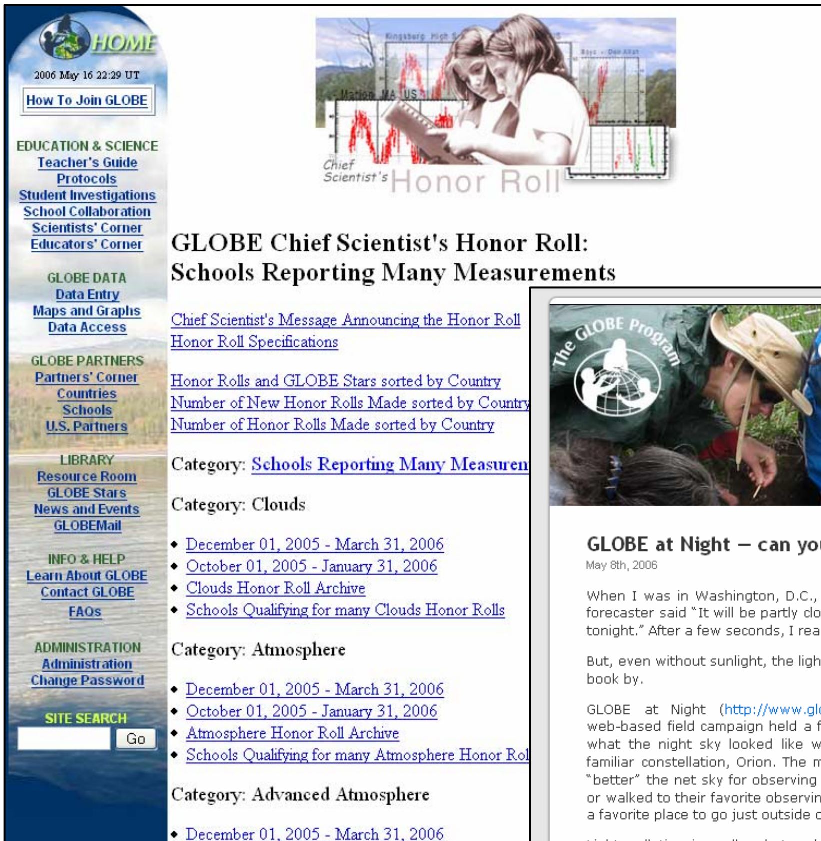
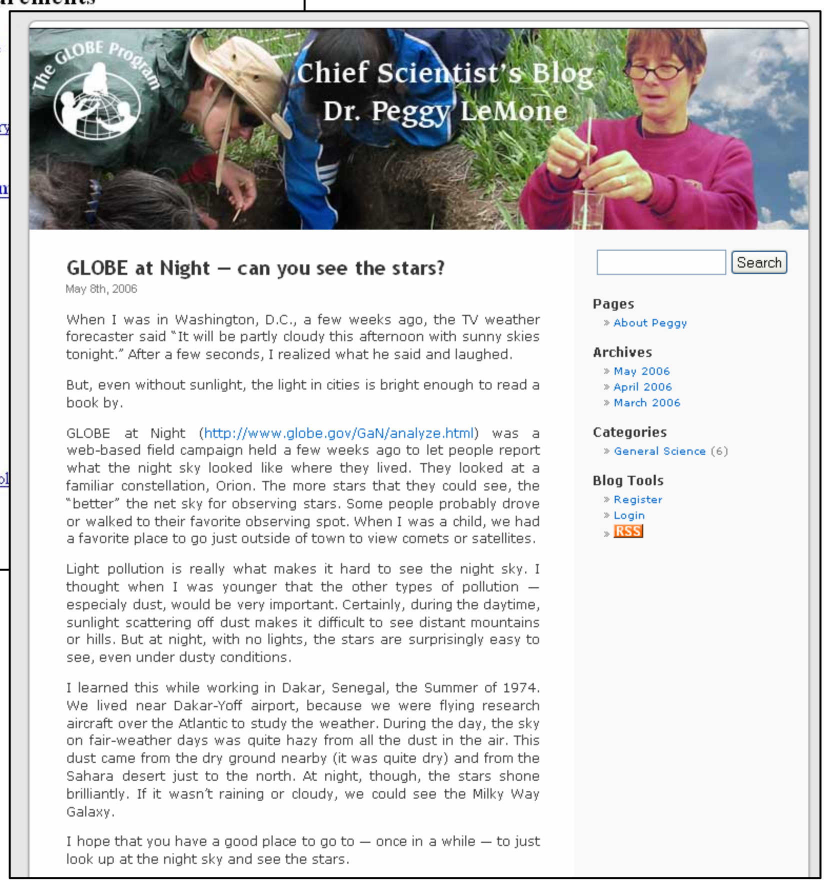
The GLOBE Program: Science Investigation Areas

-- Atmosphere
-- Hydrology
-- Land Cover/Biology
-- Soil
-- Earth as a System

The GLOBE Program





GLOBE Chief Scientist

Dr. Margaret (Peggy) LeMone

Dr. Peggy LeMone is an atmospheric scientist at the National Center for Atmospheric Research (NCAR).
She has participated in over 25 field campaigns, published over 70 articles in science journals, and over a hundred conference reports, articles in World Book Encyclopedia, and other popular venues. Dr. LeMone is a Fellow of the American Meteorological Society and the American Association for the Advancement of Science, and is a member of the National Academy of Engineering.

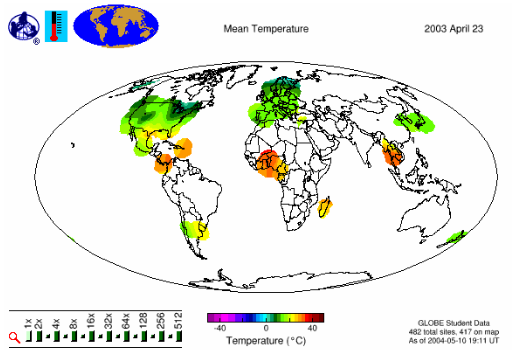
The GLOBE Program:
How it Can Aid Scientific Investigations…

GLOBE is a hands-on **science** and **education** program that has students collect scientifically valid environmental measurements and report them to a publicly available database.

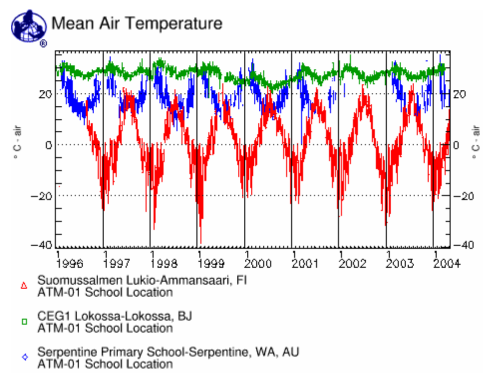
"GLOBE is the quintessentially ideal program for involving kids in science,"
- Nobel laureate Dr. Leon Lederman.

WHY USE GLOBE DATA?

Spatial and Temporal Coverage: GLOBE is a network of over 17,000 schools in over 100 countries. Over 14 million environmental measurements have been collected to date, this amount grows daily.



GLOBE Student
Mean Air Temperature Data for April 23, 2003



Comparison of mean air temperature from three different GLOBE schools

Research Quality Data: All data are collected following scientifically valid protocols, and research scientists work to ensure the accuracy of all measurements. All data reporters have undergone first-hand training.

Education and Community Outreach: The GLOBE Program offers an ideal means to partner science and education. The hands-on nature of GLOBE allows students to become involved in authentic scientific research. Since GLOBE relies on a network of partners to implement the program, it is possible to find partners eager to work with your project, or to become a partner yourself. These partnerships involve a variety of groups, such as satellite missions, university departments, science centers and museums.

GLOBE is an interagency program funded by the U.S. National Aeronautics and Space Administration (NASA) and the U.S. National Science Foundation (NSF), supported by the U.S. Department of State, and implemented through a cooperative agreement between NASA, the University Corporation for Atmospheric Research (UCAR) in Boulder, Colorado, and Colorado State University in Fort Collins, Colorado.

FOR MORE INFORMATION…
Visit the GLOBE Web site at www.globe.gov, or email our Help Desk at help@globe.gov

Science Objectives and Use of GLOBE Data

Atmosphere	Help scientists improve weather forecasting, predictions of climate change, and interpretation of satellite observations.
Combined Atmosphere, Surface, & Soil Temperature	Help scientists calculate the rate of heat exchange between the atmosphere and the soil, and the potential for decomposition and soil weathering (see also entries for Atmosphere Temperature & Soil Temperature).
Clouds and Contrails	• Help tie new measurements of clouds by automated sensors to long-term historical data records of human observations. • Help to identify cloud type more accurately than is possible by remote sensing. • Contribute to determination of how cloud climatology may be changing (a major issue in assessing climate change). • Contribute to improved interpretation of satellite observations of Earth's radiative balance. • Provide one of the only sources of ground-based observations of contrails, which are challenging to detect by remote sensing due to their small width.
Air Temperature, Precipitation, and Relative Humidity	• Provide a denser network of observations than is available using only official weather stations. • Provide finer resolution data crucial for investigating localized variations (e.g., urban heat islands, microclimates). • Augment data needed for regional forecasts and climate records in areas of the world where there are few official weather stations.
Aerosol	• Provide calibrated ground-based observations to help assess the performance of space-based instruments and to fill in the global views of aerosol distributions provided by satellite remote sensing • Detect the presence of dust, smoke, soil particles, and other aerosols and help scientists track their movement around the world.
Water Vapor	• Provide calibrated ground-based observations to help assess the performance of space-based instruments and to fill in the global views of water vapor distributions provided by satellite remote sensing. • Provide time series of water vapor to supplement non-geosynchronous space-based observations, especially in places where other ground-based instrumentation does not exist.
UV-A	• Provide calibrated ground-based observations to help assess the performance of space-based instruments and to fill in the global views of UV distributions provided by satellite remote sensing. • Provide time series and high spatial density views of the effects of clouds on the distribution of UV-A radiation on the ground.
Ozone	• Identify areas of high and low ozone concentrations and the times of year and weather conditions when they occur. • Help scientists interpret satellite observations of tropospheric ozone. • Provide quantitative measurements of ozone to help local agencies determine the extent of widespread pollution episodes.

Hydrology	Improve the monitoring of surface waters both inland and along the coasts of oceans and seas.
Transparency	• Determine how far light can penetrate the water and support the growth of algae and submerged aquatic vegetation.
Temperature	• Determine the overturning of lakes. • Track the mixing of waters in estuaries and along coasts. • Help determine evaporation rates. • Help scientists determine what can live in the water.
pH	• Help scientists determine what can live in the water, both animals and plants. • Track the mixing of waters in estuaries and along coasts. • Help scientists relate water quality to surrounding soil and geology and to the pH of rain and snow melt.
Conductivity	• Determine the overall loading of salts and other compounds dissolved in fresh water. • Help determine the usability of fresh water for different purposes.
Salinity	• Track the mixing and source of waters in estuaries and along coasts. • Help track the state of saline inland waters.
Alkalinity	• Help determine the vulnerability of fresh waters to changes in pH from inputs of acidity.
Dissolved Oxygen	• Determine what animals can live in the water. • Help scientists determine the mixing of air and water at the water's surface.
Nitrates	• Help scientists determine the potential uses of water. • Help determine the effects of inputs of nutrients from surrounding areas on a water body.
Fresh Water Macroinvertebrates	• Help determine the biodiversity of a fresh water ecosystem. • Help scientists determine the overall state of a water body.
Marine Macroinvertebrates	• Help determine the biodiversity of coastal beach ecosystems. • Help determine the overall state of coastal beach ecosystems. • Test the hypothesis that the distributions of marine animals will change with climate change.

Soil	Help scientists understand soils and how they function, change, and affect other parts of the ecosystem, such as climate, vegetation and hydrology.
Temperature	• Provide new data for tracking climate and annual cycles. • Help scientists determine times of insect emergence and plant sprouting. • Help determine heat transport in near-surface soil. • Help understand the potential for decomposition and weathering of soil. • Help scientists monitor the energy balance of the Earth system.
Moisture	• Help track the water cycle in the Earth system. • Help determine the times of plant sprouting and growth. • Help scientists improve weather and climate prediction. • Help understand the potential for decomposition and weathering of soil. • Compare with existing models and data sets for validation and for local detail.
Field Characterization (structure, color, consistence, texture, and the presence of rocks, roots, & carbonates)	• Help scientists create soil maps. • Help track the global carbon cycle. • Provide information for interpretation of soil temperature and moisture measurements. • Help to interpret the history of the soil. • Provide information to determine the appropriate uses of a soil.
pH	• Help determine what can grow in the soil. • Help determine the effect on the pH of water flowing through soil. • Give insight into other chemical properties in the soil.
Bulk Density	• Help in the interpretation of soil temperature and moisture measurements. • Help determine soil porosity (volume of empty space for air and water) in combination with Particle Density. • Provide some indication of mineral versus organic content of soils. • Help understand the ability of roots or organisms to penetrate the soil horizon.
Particle Density	• Help determine soil porosity (volume of empty space for air and water) in combination with Bulk Density. • Provide some indication of mineral versus organic content of soils. • Help in the interpretation of soil temperature and moisture measurements.
Fertility	• Indicate the suitability of the soil for supporting growth of crops and other plant life. • Provide indication of nitrate and phosphate inputs to water bodies.
Particle Size Distribution	• Determine the mixture of sand, silt, and clay particles in soil. • Provide information to help determine the appropriate uses of a soil. • Provide information for interpretation of soil temperature and moisture measurements. • Provide critical information for mathematical modeling of water, energy, and carbon dynamics in soils.

Land Cover	Help scientists study the terrestrial components of the energy, water, carbon, nitrogen, and other cycles of the Earth system. Help in the understanding of local climate and watersheds.
Sample Site	• Classify land cover for comparison with maps derived from satellite remote sensing.
Biometry	• Help scientists determine the amount of biomass present. • Help validate land cover classifications of sample sites.
Mapping	• Guide systematic observation of land cover classification.
Change	• Determine land cover change in support of the study of changes in local climate, watersheds, and the cycles of the Earth system.

Fuels	Help scientists identify those areas with high fire danger to protect people, homes, and ecosystems.
Fuel loadings	• Determine the spread rate and intensity of wildland fires. • Calculate the amount of smoke emissions from the fire. • Compute the amount of carbon added to the atmosphere due to a fire. • Calculate the carbon reserves in the dead biomass .
Fuel characteristics	• Calculate fuel consumption and soil heating. • Estimate habitat for organisms depended on coarse woody debris. • Compute tree mortality from fire.

Phenology	Help scientists detect the nature and extent of climate change and its effects on plants and animals.
Green-up, Green-down Budburst, Lilacs, Phenological Gardens	• Delineate the length, start and end of the growing season. • Help scientists interpret satellite observations of greenness.
Hummingbirds	• Determine changes in hummingbird migration as both an indicator and response to climate changes and land cover.
Seaweed Reproduction Phenology	• Determine changes in seaweed reproduction as both an indicator and response to climate changes.
Arctic Bird Migration	• Determine changes in Arctic bird migration as both an indicator and response to global and regional climate changes.

GLOBE Ties to Satellite Missions

AIM
- Aerosols
- Clouds and Contrails
- Column Water Vapor
- Carbon Dioxide (to be developed)

AVHRR
(Instrument on various NASA/NOAA satellites)
- Phenology
- Surface Temperature
- Soil Characterization
- Snow
- Clouds and Contrails

CALIPSO
- Aerosols

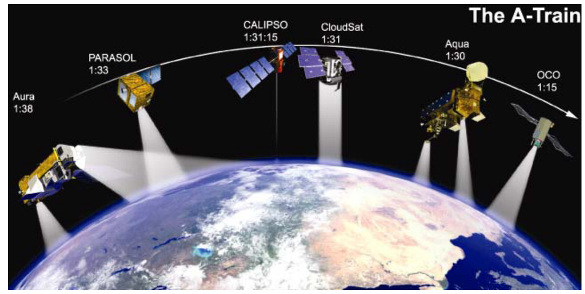
CERES
- Clouds and Contrails

CloudSat
- Clouds and Contrails

ENVISAT
- Aerosols

EOS-Aura
- Surface Ozone
- UVA (to be developed)

EOS- Terra and Aqua
- Land Cover
- Surface Temperature
- Soil Characterization
- Snow
- Clouds and Contrails
- Aerosols
- Column Water Vapor



A group of satellites known as the Afternoon Constellation, or the A-Train. By flying in close proximity, satellites in the A-Train combine to provide detailed observations of the Earth system. GLOBE measurements will contribute to the validation of these missions.

GOES
- Aerosols
- Clouds and Contrails
- Surface Temperature

Landsat
- Clouds and Contrails
- Snow
- Land Cover
- Soil Characterization
- Surface Temperature

OCO
- Carbon Dioxide (to be developed)

SPOT
- Land Cover
- Soil Characterization

TOMS
(Instrument on various NASA/NOAA satellites)
- Surface Ozone

GLOBE Partnerships with Satellite Missions

Satellite(s)	Instrument(s)	GLOBE Protocol(s)
ESSP CloudSat (Earth System Science Pathfinder Project)	**CPR** (Cloud Profiling Radar)	Atmosphere
EOS Terra and Aqua (Earth Observing System)	**MODIS** (Moderate Resolution Imaging Spectroradiometer) **CERES** (Clouds and the Earth's Radiant Energy System) **AMSR/E** (Advanced Microwave Scanning Radiometer-EOS) **AMSU** (Advanced Microwave Sounding Unit) **AIRS** (Atmospheric Infrared Sounder) **HSB** (Humidity Sounder for Brazil) **MOPITT** (Measures of Pollution in the Troposphere) **MISR** (Multi-angle Imaging SpectroRadiometer)	Land Cover Surface Temperature Hydrology Atmosphere Aerosols Column Water Vapor
ESSP CALIPSO (Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations)	**LIDAR** (LIght Detection And Ranging)	Atmosphere Aerosols
LandSat	**ETM+** (Enhanced Thematic Mapper Plus)	Clouds and Contrails Snow Land Cover Soil Characterization Surface Temperature
EOS Aura	**OMI** (Ozone Monitoring Instrument) **HIRDLS** (High Resolution Dynamics Limb Sounder) **MLS** (Microwave Limb Sounder) **TES** (Tropospheric Emission Spectrometer)	UVA Surface Ozone Atmosphere Aerosols
AIM (Aeronomy of Ice in the Mesosphere)	**SOFIE** (Solar Occultation for Ice Experiment) **CIPS** (Cloud Imaging and Particle Size Experiment) **CDE** (Cosmic Dust Experiment)	Clouds and Contrails Aerosols Column Water Vapor Carbon Dioxide (in design stage)
GOES (Geostationary Operational Environmental Satellite)	**GOES I-M** Imager Sounder Space Environmental Monitor	Atmosphere Aerosols Surface Temperature
SPOT (commercial satellites)	**HRS** (High Resolution Stereoscopic)	Land Cover Soil Characterization
Various NOAA/NASA satellites	**AVHRR** (Advanced Very High Resolution Radiometer)	Clouds and Contrails Phenology Hydrology Surface Temperature Soil Characterization Water Vapor
Earth Probe TOMS satellite	**TOMS** (Total Ozone Mapping Spectrometer)	Surface Ozone
ESSP OCO (Orbiting Carbon Observatory)	Spectrometer	Carbon Dioxide (in design stage)
AIM (Aeronomy of Ice in the Mesosphere)	**SOFIE** (Solar Occultation For Ice Experiment) **SHIMMER** (Spatial Heterodyne IMager for MEsospheric Radicals) **CIPS** (Cloud Imaging and Particle Size experiment) **CDE** (Cosmic Dust Experiment)	Polar Mesopheric Clouds (in design stage)

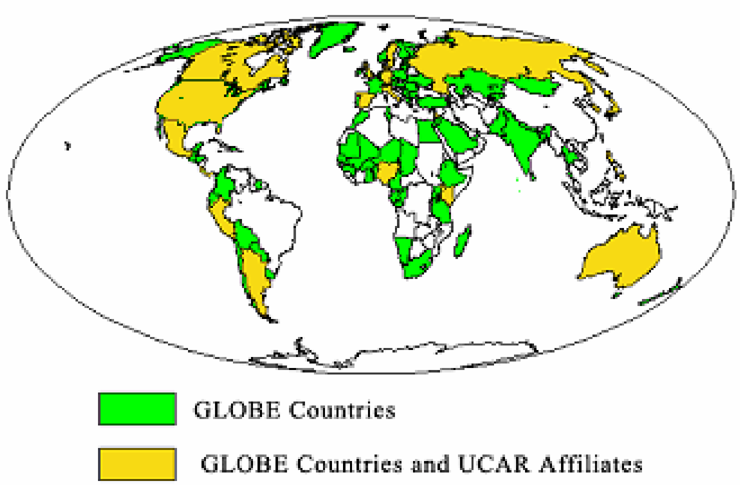
WAYS TO BECOME INVOLVED IN GLOBE

1) Work with an existing partner
GLOBE has partners in 108 countries and almost all U.S. states. The complete list of these partners, including contact information, can be found on the *Countries* and *U.S. Partners* links found on the GLOBE Web site at <www.globe.gov>. The diversity of partnerships makes it possible to find partners that are appropriate for inclusion in an array of projects.

2) Include GLOBE in the outreach portion of your scientific projects

GLOBE would be glad to suggest ways that you could incorporate portions of our program into your project. Please email the GLOBE Program Office at <regionalscienceprojects@globe.gov> to discuss possible collaborations.

3) Use GLOBE data in your research project
All GLOBE data are publicly available. With data ranging from land cover classifications in Bahrain to cloud observations in the Marshall Islands, you may be able to find just what you are looking for. Powerful search tools on the GLOBE Web site allow you to narrow down the exact data you need. Numeric data can be downloaded in a variety of formats (web-based, delineated text, or shape files), or visualized using our online mapping and graphing tools.



GLOBE countries that have UCAR Affiliate Institutions, depicted in yellow in the graphic below, include Argentina, Australia, Canada, Denmark, Germany, Japan, Israel, Italy, Kenya, South Korea, Mexico, Nigeria, Panama, Peru, Philippines, Russia, Spain, Sweden, the United Kingdom and the United States.